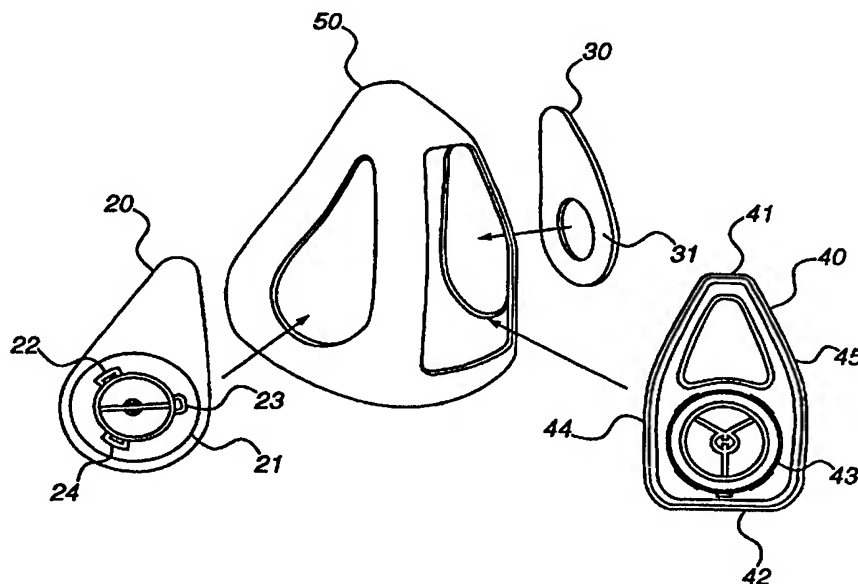




## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>6</sup> :</b> <b>A62B 18/02</b>	<b>A1</b>	<b>(11) International Publication Number:</b> <b>WO 96/40370</b> <b>(43) International Publication Date:</b> 19 December 1996 (19.12.96)
<b>(21) International Application Number:</b> PCT/US96/06619 <b>(22) International Filing Date:</b> 9 May 1996 (09.05.96)  <b>(30) Priority Data:</b> 08/485,172                      7 June 1995 (07.06.95)                      US  <b>(71) Applicant:</b> MINE SAFETY APPLIANCES COMPANY [US/US]; P.O. Box 426, Pittsburgh, PA 15230-0426 (US).  <b>(72) Inventor:</b> FREUND, Paul, X.; 53 Tenacity Trail, Mars, PA 16046 (US).  <b>(74) Agent:</b> UBER, James, G.; Mine Safety Appliances Company, P.O. Box 426, Pittsburgh, PA 15230-0426 (US).		<b>(81) Designated States:</b> AM, AT, AU, BB, BG, BR, BY, CA, CH, CN, CZ, DE, DK, EE, ES, FI, GB, GE, HU, IS, JP, KE, KG, KP, KR, KZ, LK, LR, LT, LU, LV, MD, MG, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, TJ, TM, TT, UA, UG, UZ, VN, ARIPO patent (KE, LS, MW, SD, SZ, UG), European patent (AT, BE, CH, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>

**(54) Title:** RESPIRATOR MASK WITH STIFFENING ELEMENTS



**(57) Abstract**

The present invention provides a respirator mask (figure 1) having a very soft, compliant facepiece (10) that has several stiffening elements (20, 30 and 40) integrated therein. The respirator mask preferably includes an exhalation valve and a pair of filter cartridges. It also has a yolk (62) which complements the facepiece (10) and provides for attachment of a harness (70) to secure the respirator mask to the user's face. The respirator mask is lightweight and extremely comfortable due to the novel facepiece (10) made of three stiffening elements (20, 30 and 40) which are completely surrounded by and bonded to a flexible material (50).

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## RESPIRATOR MASK WITH STIFFENING ELEMENTS

### FIELD OF THE INVENTION

The present invention relates to respirator masks worn on a user's face for protection  
5 against gases, vapors and particulates, and more particularly to a half-mask respirator.

### BACKGROUND OF THE INVENTION

Most respirators have a facepiece made of a soft compliant material, typically rubber,  
that rests against the wearer's face and forms a seal in conjunction with the wearer's facial  
skin. Some respirators are made of thick rubber to support the filters and exhalation valve  
10 attached thereto. See, e.g., U.S. Patent Nos. 2,652,828 (Matheson) and 4,155,358  
(McAllister et al.). Thick rubber can make the respirator heavy and uncomfortable to wear.  
Additionally, the thicker the rubber, the more costly it is to manufacture the respirator due to  
the increased material costs. If the rubber is made thinner, the mask tends to collapse onto  
the user's face, particularly while tightening the harness after donning the respirator. U.S.  
15 Patent No. 5,062,421 (Burns) describes a respirator mask which incorporates a large single  
insert that serves as a structural member to support the facepiece. The disadvantage with the

Burns respirator is that it is not flexible enough to provide a comfortable fit over a wide range of face sizes.

It is desirable, therefore, to provide a better fitting, lightweight respirator mask with a firm but flexible facepiece, that is more versatile and economical to make than existing respirator masks. Similarly, the respirator mask should be comfortable to wear for extended periods of time without collapsing on the user's face.

### SUMMARY OF THE INVENTION

Generally, the present invention provides a very comfortable and lightweight respirator mask having a soft compliant facepiece with more than one stiffening elements integrated therein. Preferably, there are three stiffening elements which contain apertures and a mechanism for attaching filter cartridges and an exhalation valve to the facepiece. The integral stiffening elements are made of a lightweight rigid material, preferably a plastic such as polypropylene, and are joined by a flexible material, preferably thermoplastic rubber, such that the facepiece is flexible enough to provide a comfortable seal on the wearer's face but stiff enough to preclude collapse against the wearer's face. The respirator further comprises a yolk featuring a centered exhalation valve cover. The yolk wraps around the facepiece and has apertures that correspond to those in the stiffening elements. The filter cartridges are preferably attached to a connector on the appropriate stiffening elements. A harness is

harness is attached to the yolk to position and secure the respirator on the wearer's head. Such harness may be attached to the yolk by apertures on each arm of the yolk.

Other details and advantages of the present invention will become apparent as the following description of the invention proceeds.

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## THE DRAWINGS

In the accompanying drawings, preferred embodiments of the invention and preferred methods of practicing the invention are illustrated in which:

FIG. 1 is a perspective view of a respirator of the present invention; and

FIG. 2 is a perspective exploded view of a facepiece of the present invention.

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## PRESENTLY PREFERRED EMBODIMENT

A presently preferred embodiment of the invention is shown in Figures 1 and 2. Respirator facepiece 10 preferably comprises three stiffening elements 20, 30, and 40, respectively, made of a lightweight material, preferably a moldable plastic, and more preferably polypropylene or glass filled polypropylene, which are held together by a thermoplastic rubber 50, preferably one that has polypropylene in it such as kraton, starflex or sanoprene. Two of the stiffening elements 20 and 30 comprise the sides of the facepiece, are mirror images of each other, and are shaped substantially like teardrops with generally

circular apertures 21 and 31, respectively, located in the base of the teardrop. The stiffening elements are bonded at their outer edge to ensure a seal with the rubber. Furthermore, the stiffening elements may be slightly curved to better accommodate facial features. The apertures 21 and 31 in the side stiffening members 20 and 30 are of sufficient size to  
5 accommodate commercially available filter cartridges and are adjacent to a connector for attaching such filters to the stiffening elements. In one embodiment, the side stiffening members possess flanges 22, 23, 24, 32, 33 and 34 for mating with the flanges of such filter cartridges.

The center stiffening member 40 is generally rectangular in shape, preferably with  
10 one end 41 being slightly narrower than the other end 42, and having an aperture 43 substantially centered from the sides of the rectangle 44 and 45 and located closer to the longer end of the rectangle. The aperture 43 in the center member is preferably circular and of sufficient size to accommodate an exhalation valve therein.

The flexible material 50 of the facepiece is preferably a thermoplastic rubber that has  
15 polypropylene in it. Preferably, it is made by injection molding using a cavity conforming to the desired shape of the facepiece and adapted to accommodate positioning the stiffening elements 20, 30, and 40 in their final desired positions in the facepiece. The center member 40 is positioned in the mold with the narrower end 41 of its rectangular shape on top and between the points of the two teardrop shaped side member 20 and 30 such that after  
20 molding the side members may move in hinge-like fashion in relation to the center member.

When the thermoplastic rubber is injected into the mold, the thermoplastic rubber bonds directly to each stiffening element to form a seal around it. Preferably, each stiffening element is mechanically bonded to the rubber so that it can move relative to the adjacent stiffening elements and thereby provide the needed flexibility. The configuration of the mold, and the positioning of the stiffening elements therein, permits the thermoplastic rubber to completely surround each edge of every stiffening element, including the aperture edge, such that the stiffening elements are separated from one another by a strip of thermoplastic rubber, and each aperture in the side stiffening members is encased by the thermoplastic rubber so as to be able to form a friction fit with a filter cartridge. Alternatively, one could use other flexible materials which would form a chemical bond to the lightweight stiffening elements. Such flexible materials include hycar or silicon rubber. Of course, one would have to use a primer with these materials to achieve a chemical bond between the rubber and the stiffening elements.

A yolk 60 is typically placed on top of the facepiece 10. The yolk is made of a semi-rigid material, preferably plastic. When the respirator is assembled, the yolk is centered on and extends across the exterior surface of the facepiece. In the center of the yolk is an exhalation valve cover 61 that mates with the exhalation valve aperture 43 of the facepiece. The yolk has two halves 62 that extend from opposing sides of the exhalation valve cover 61. Each half 62 of the yolk has a substantially circular aperture (not shown) that complements the corresponding substantially circular filter cartridge aperture 21 and 31 on the facepiece 10.

From each half 62 of the yolk 60 extend two prongs 67 and 68 that contain openings 64 and 65 at the end of each prong for receiving a harness 70 that will position and secure the facepiece 10 and yolk 60 to head of the wearer.

5 The harness 70 preferably consists of three adjustable elastic straps 71, 72 and 73 that are attached to the yolk 60. The top straps 71, 72 of the harness are attached to two strips of plastic that form a headband 74 which fits over the crown of the wearer's head. An adjustable bottom strap 73 fits around the wearer's neck and is threaded through an aperture 65 in the yolk. The wearer may adjust the fit of the respirator mask by tightening or loosening the elastic straps. Such adjustments may be made while the respirator mask is  
10 worn.

Although the invention has been described in detail above for the purpose of illustration, it is to be understood that such detail is solely for that purpose and that variations can be made therein by those of ordinary skill in the art without departing from the spirit and scope of the invention as defined by the following claims including all  
15 equivalents thereof.



What is claimed is:

1. In a respiratory mask having a facepiece with filter cartridges attached thereto, the improvement wherein the facepiece comprises a plurality of stiffening elements connected together by a flexible material.
2. The respiratory mask as in claim 1, wherein the flexible material completely surrounds each stiffening element so that they are separated from one another by the flexible material but can be moved in relation to each other.
3. The respiratory mask as in claim 2 wherein there are three stiffening elements.
4. The respiratory mask as in claim 3, wherein the three stiffening elements comprise two side members, each with an aperture and connector to accommodate a filter cartridge, and a center member with an aperture to accommodate an exhalation valve.
5. The respiratory mask as in claim 3 wherein the stiffening elements are made of plastic material.
6. The respiratory mask as in claim 5 wherein the plastic material is polypropylene.

7. The respiratory mask as in claim 3 wherein the flexible material is thermoplastic rubber.
8. The respiratory mask as in claim 6 wherein the flexible material is a thermoplastic rubber containing polypropylene.
9. A facepiece for a respiratory mask comprising a plurality of polypropylene stiffening elements connected together by a flexible thermoplastic rubber that has polypropylene in it.
10. The facepiece as in claim 9 wherein the flexible thermoplastic rubber is mechanically bonded to and completely surrounds each stiffening element so that they are separated from one another by the thermoplastic rubber but can move in relation to each other.
11. The facepiece as in claim 10 wherein there are three stiffening elements.
12. The facepiece as in claim 11, wherein the three stiffening elements comprise two side members, each with an aperture and a connector to accommodate a filter cartridge, and a center member with an aperture to accommodate an exhalation valve.
13. The facepiece as in claim 12 wherein the connector comprises at least one flange.
14. A respiratory mask comprising:

a facepiece wherein a plurality of stiffening elements are connected together in hinge-like fashion by a flexible material;  
a filter cartridge connected to the facepiece;  
an exhalation valve connected to the facepiece; and  
a harness connected to the facepiece.

15. The respiratory mask as in claim 14, wherein the flexible material completely surrounds each stiffening element so that they are separated from one another by the flexible material but can be moved in relation to each other.

16. The respiratory mask as in claim 15 wherein there are three stiffening elements.

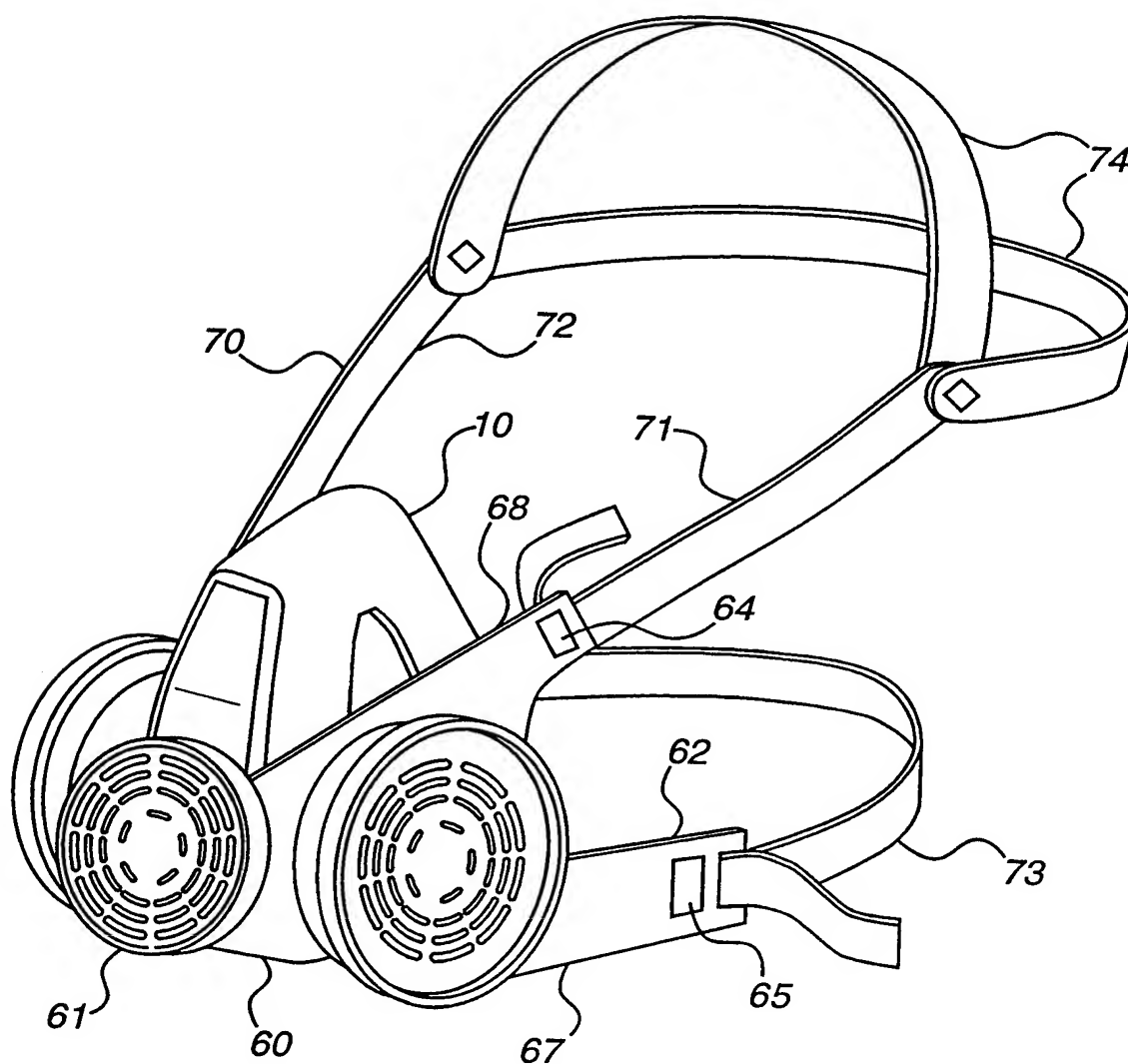
17. The respiratory mask as in claim 16, wherein the three stiffening elements comprise two side members, each with an aperture and a connector to accommodate a filter cartridge, and a center member with an aperture to accommodate an exhalation valve.

18. A respiratory mask as in claim 17 wherein the connector comprises a plurality of flanges for a bayonet-type mounting mechanism that will mate with a plurality of flanges on the filter cartridge.

19. A respiratory mask as in claim 16 wherein the stiffening elements are made of polypropylene.

20. A respiratory mask as in claim 19 wherein the flexible material is a thermoplastic rubber that has polypropylene in it.

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*Figure 1*

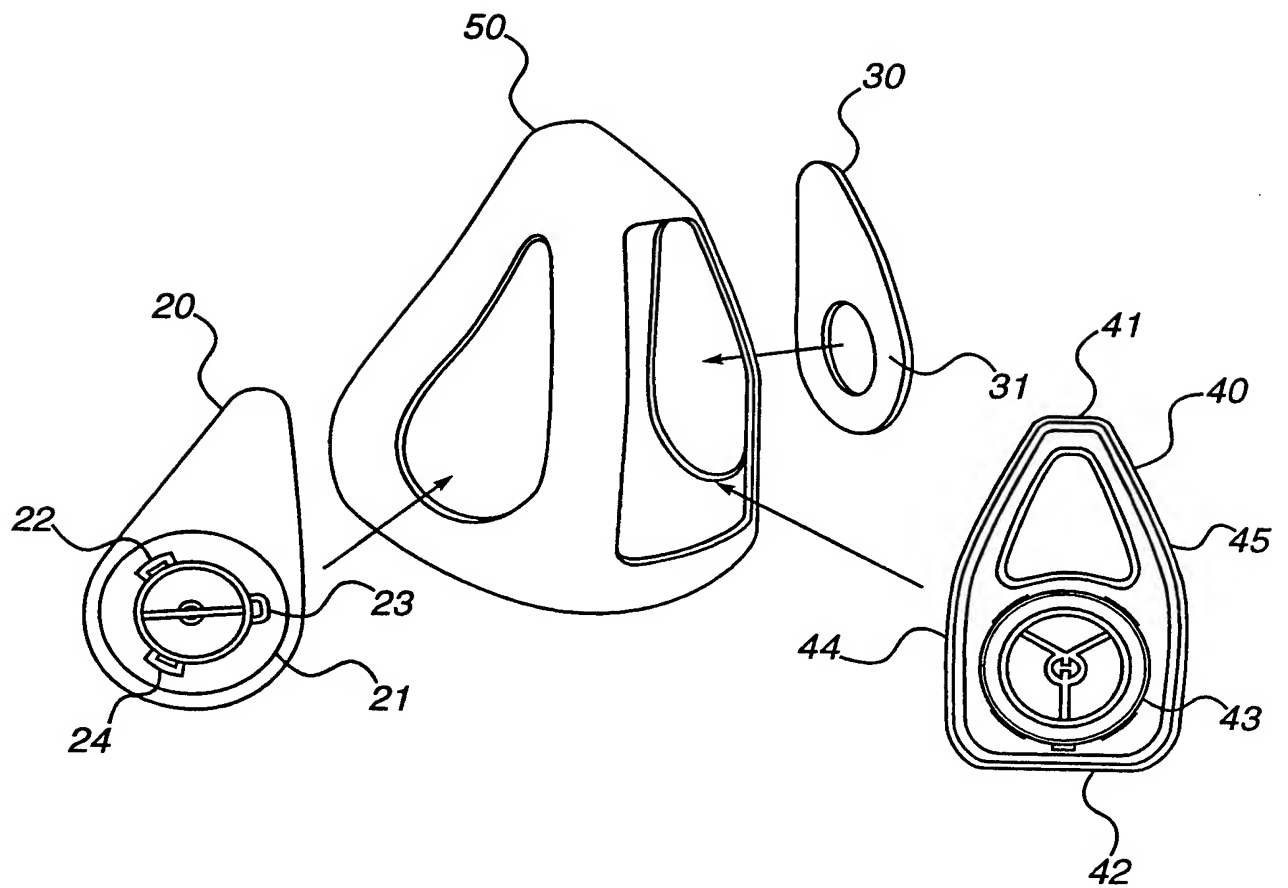


Figure 2

# INTERNATIONAL SEARCH REPORT

In national Application No

PCT/US 96/06619

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 6 A62B18/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 6 A62B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP,A,0 309 277 (MINNESOTA MINING AND MANUFACTURING COMPANY) 29 March 1989	1-3,7
Y	see column 6, line 3 - column 8, line 12; figures	4,14-17
Y	--- US,A,5 062 421 (MINNESOTA MINING AND MANUFACTURING COMPANY) 5 November 1991 cited in the application see column 4, line 48 - column 5, line 35; figures	4,14-17
A	--- EP,A,0 613 699 (BEARD) 7 September 1994 see column 2, line 44 - column 4, line 42; figures -----	1,14

☐ Further documents are listed in the continuation of box C.

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Date of the actual completion of the international search

9 September 1996

Date of mailing of the international search report

23.09.96

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# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP-A-309277	29-03-89	US-A- 4790306	13-12-88
		AU-B- 2116088	06-04-89
		CA-A- 1322969	12-10-93
		DE-D- 3852857	09-03-95
		DE-T- 3852857	10-08-95
		ES-T- 2066788	16-03-95
		JP-A- 1107776	25-04-89
-----			
US-A-5062421	05-11-91	NONE	
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EP-A-613699	07-09-94	GB-A- 2275614	07-09-94
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